



An Energy Efficiency Workshop & Exposition  
Kansas City, Missouri

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# GEOEXCHANGE

*Geothermal Energy for  
Agencies without Hot Rocks*

Douglas Sattler, P.E., C.E.M.





## *Agenda*

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- Cost Savings with Geoexchange
- Case Studies
- Prerequisites for Geoexchange ECMs in Super ESPCs

June 3-6, 2001

[www.energy2001.ee.doe.gov](http://www.energy2001.ee.doe.gov)





## ***NOT a prereq for Georexchange***

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## Geoexchange saves energy

- o Geoexchange most energy efficient and cost effective system
- o Reduce energy consumption
  - >40% compared to Air Source HP
  - >70% compared to Elect. Resistance w/ DX
- o Demand reduction



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### Ft. Polk

4003 Houses

- Geoexchange
- CFL
- Insulation



- 33% kWh reduction
- 260,000 Therms
- 7.5 MW demand reduction



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## ***Geothermal saves maint. \$***

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- o Geothermal maintenance cost: 10¢/sf
- o Other systems 20 – 30 ¢/sf and up

### **Why?**

- è Heat Pumps: 20 yr life
- è Ground Loops: 50+ yr life
- è Refrigerant circuit hermetically sealed
- è Most applications closed loop



## ***Richard Stockton College***



- Public four-year college
  - Atlantic City, NJ
  - 5600 full-time students
- Main campus facility
  - 3 buildings
  - 14 wings
  - ~400,000 sq. ft.
- Existing equipment (1993)
  - 20 yr old Nesbitt & Lennox multizone rooftop units
  - Gas fired w/DX
  - End of Life

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## *Richard Stockton College*



- 1680 Ton Borefield
  - vertical, closed-loop w/ central well field
  - 400 bores, 425 ft. deep
  - 340,000 ft. total
  - 121 ft/ton
  - 4,500 gpm max water flow
- ~120 Heat Pumps

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## ***Richard Stockton College***

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- **World's Largest Central Geothermal Wellfield**



**Wellfield installed under  
4 acre parking lot**





## ***Richard Stockton College***



- 2<sup>nd</sup> Year Savings
  - 1,985,860 kWh @ 0.0808 ¢/kWh
  - 110,227 Th @ 66 ¢/Th
  - \$107,100 demand
- \$300,000 Total
- NIC Maintenance Savings

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## ***Richard Stockton College***



- HVAC capital cost:
  - \$4,964,596 (Geothermal)
  - \$3,567,493 (Conventional)
  - \$1,397,103 (Premium)
- Savings:
  - \$300,000
- Simple Payback:
  - 4.65 years incremental
  - 1.6 years w/rebate (\$800/T)

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## ***Patuxent River NAS***

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- o DOE GHP Super ESPC
- o Delivery Order Award 9/00
- o Logistics Industrial Complex
- o Aircraft Electrical Evaluation Facility
- o Frank Knox School
- o Bldg 1406-offices

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## ***Patuxent River NAS***

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- Logistics Industrial Complex
  - Six Administrative Buildings
  - Central Steam Boilers in Bldg 446
  - Cooling by:
    - Window Units
    - Rooftop DX
    - Air cooled chiller
    - Split systems



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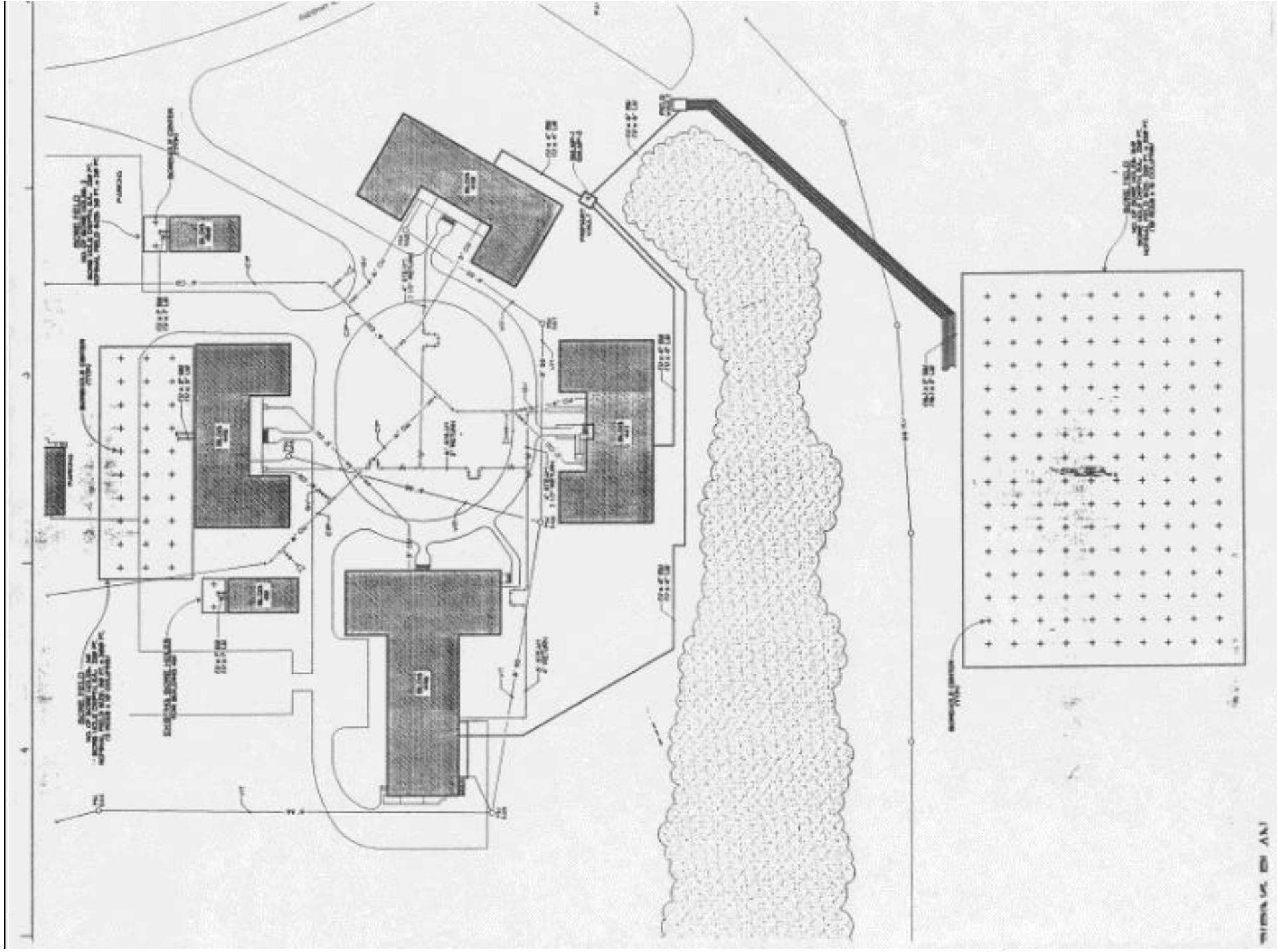




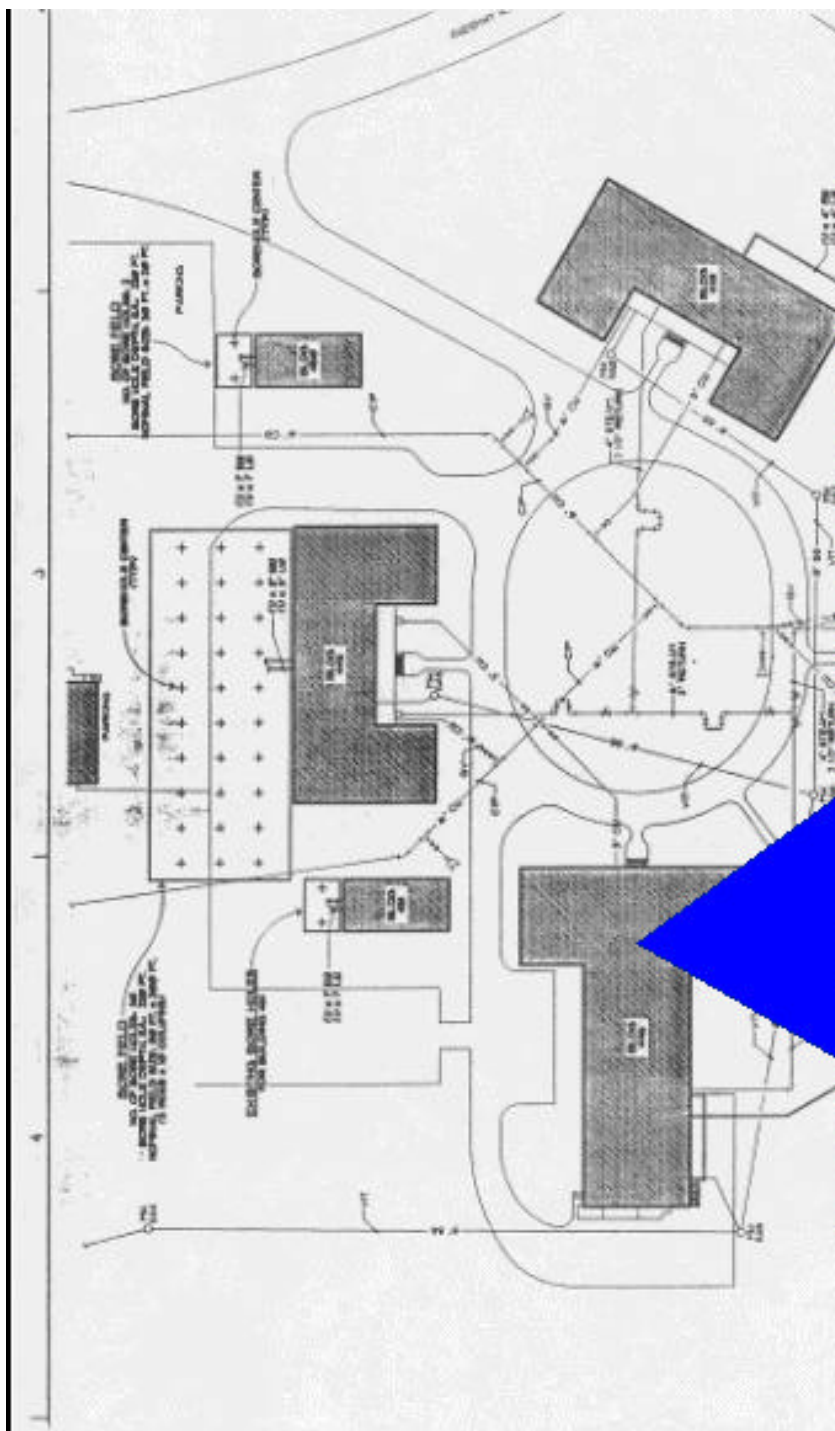
## ***Patuxent River NAS***

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- Project Drivers
  - Steam system in disrepair
  - Building systems out of control
- Retrofit Strategy
  - Geothermal Heat Pumps
  - VSD Pumping
  - Exit Signs
- Savings
  - 1,114,812 kWh @ ~ 7¢/kWh (over 40%)
  - 121,979 Therms @ ~ \$1/Th



# Building 446









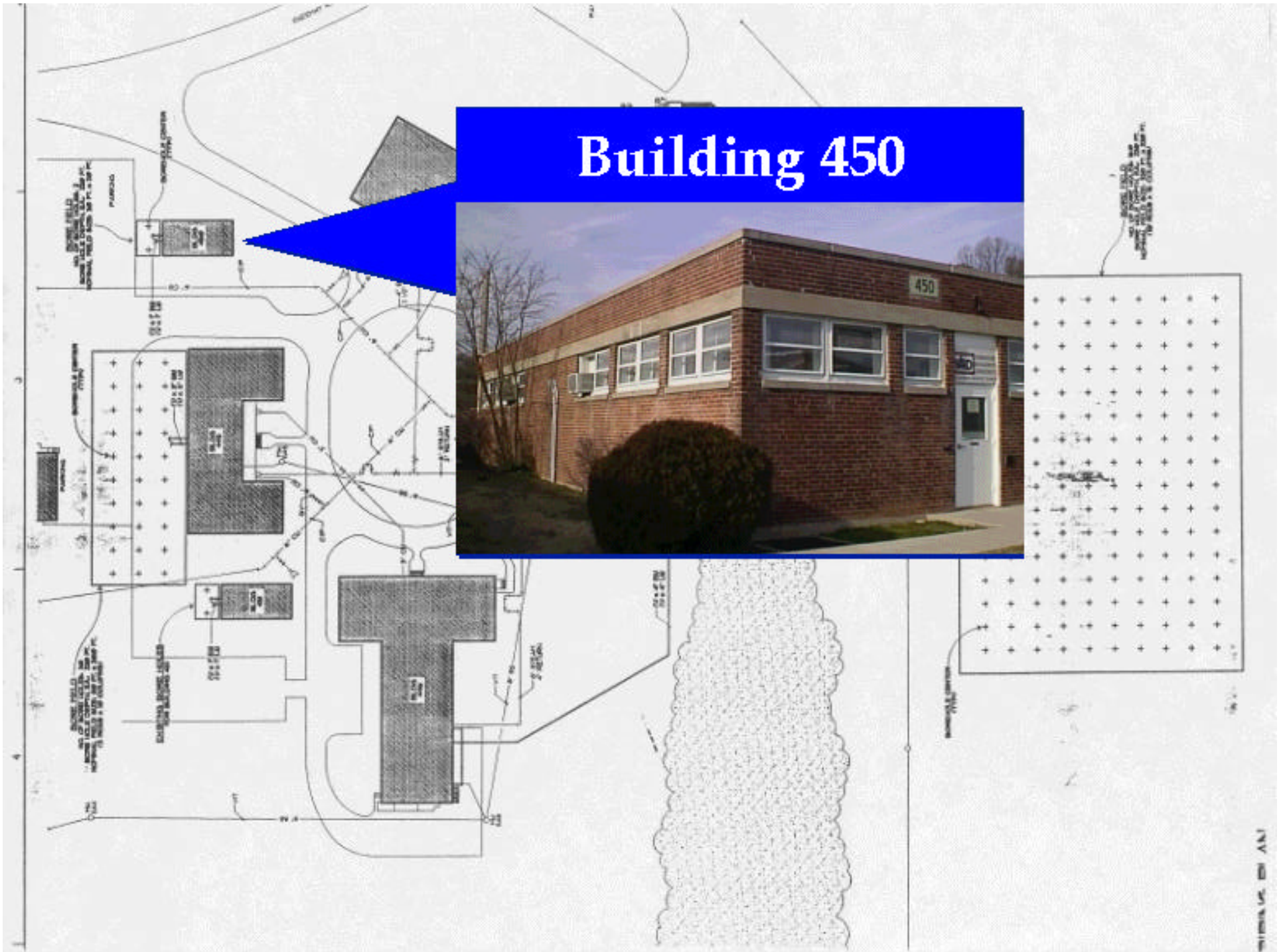


Architectural site plan of a campus. A blue triangle points to a building labeled 'BUILDING 448'. Other labels include 'NORMAN CENTER', 'NORMAN FIELD', 'NORMAN FIELD SOUTH', 'NORMAN FIELD NORTH', 'NORMAN FIELD EAST', 'NORMAN FIELD WEST', 'NORMAN FIELD CENTRAL', 'NORMAN FIELD NORTHWEST', 'NORMAN FIELD SOUTHWEST', 'NORMAN FIELD NORTHEAST', 'NORMAN FIELD SOUTHEAST', 'NORMAN FIELD CENTRAL EAST', 'NORMAN FIELD CENTRAL WEST', 'NORMAN FIELD CENTRAL NORTH', 'NORMAN FIELD CENTRAL SOUTH', 'NORMAN FIELD CENTRAL NORTHWEST', 'NORMAN FIELD CENTRAL SOUTHWEST', 'NORMAN FIELD CENTRAL NORTHEAST', 'NORMAN FIELD CENTRAL SOUTHEAST', 'NORMAN FIELD CENTRAL NORTHWEST', 'NORMAN FIELD CENTRAL SOUTHWEST', 'NORMAN FIELD CENTRAL NORTHEAST', 'NORMAN FIELD CENTRAL SOUTHEAST'. A large tree is shown to the right of Building 448. A parking lot is shown to the left of Building 448. A road is shown at the top of the plan. A building with a grid of windows is shown to the right of Building 448.

# Building 448



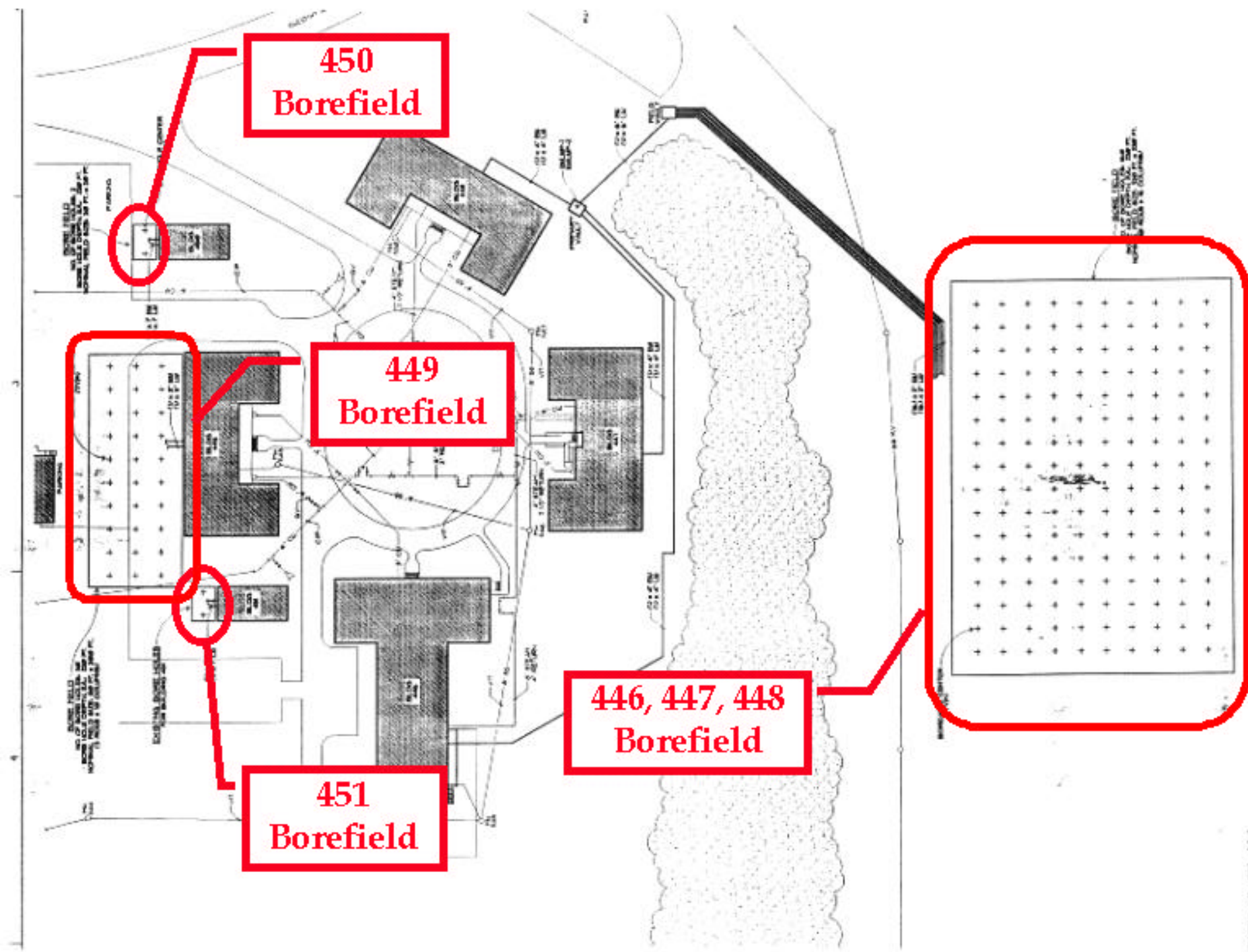
# Building 450





# Building 451







**450  
Borefield**

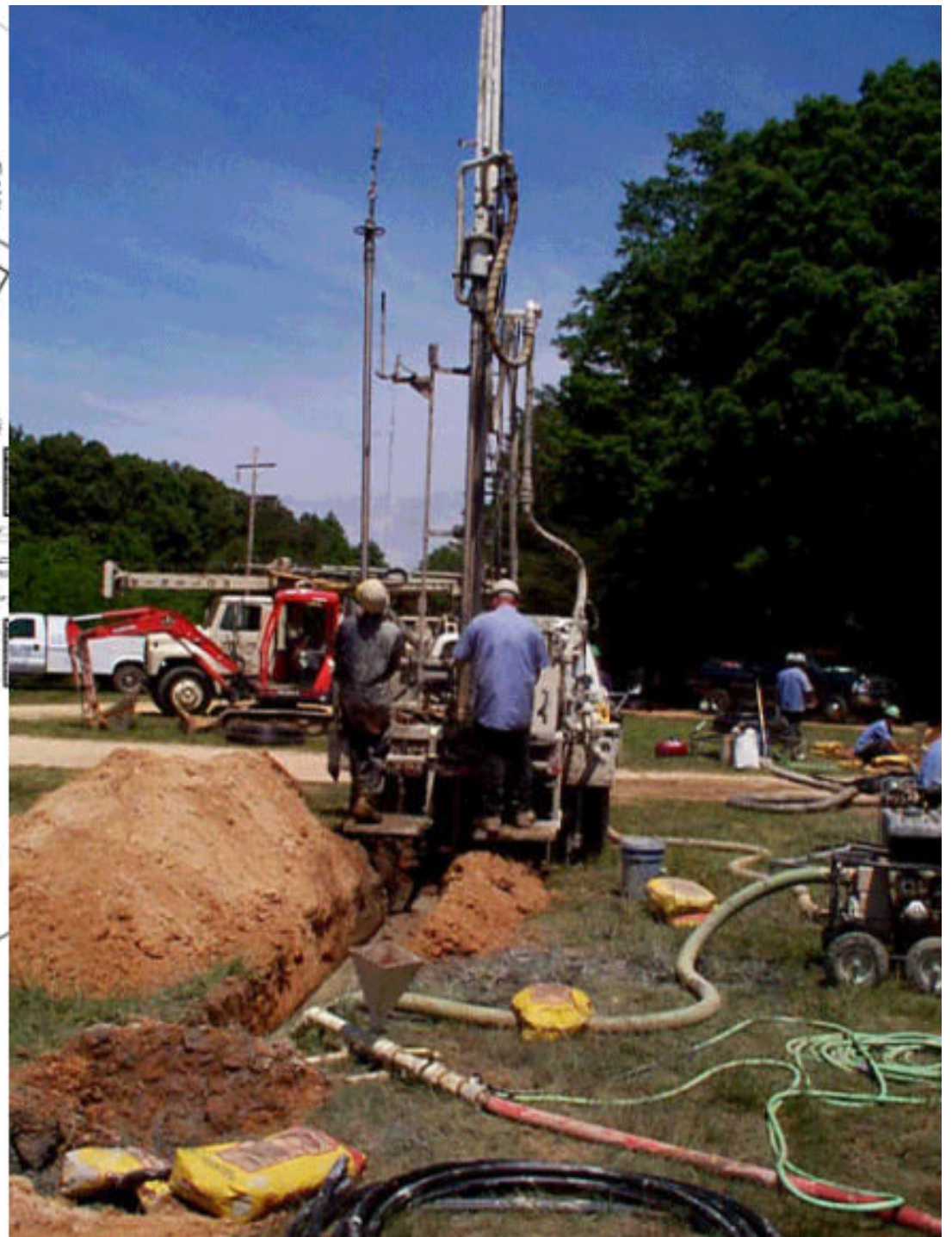
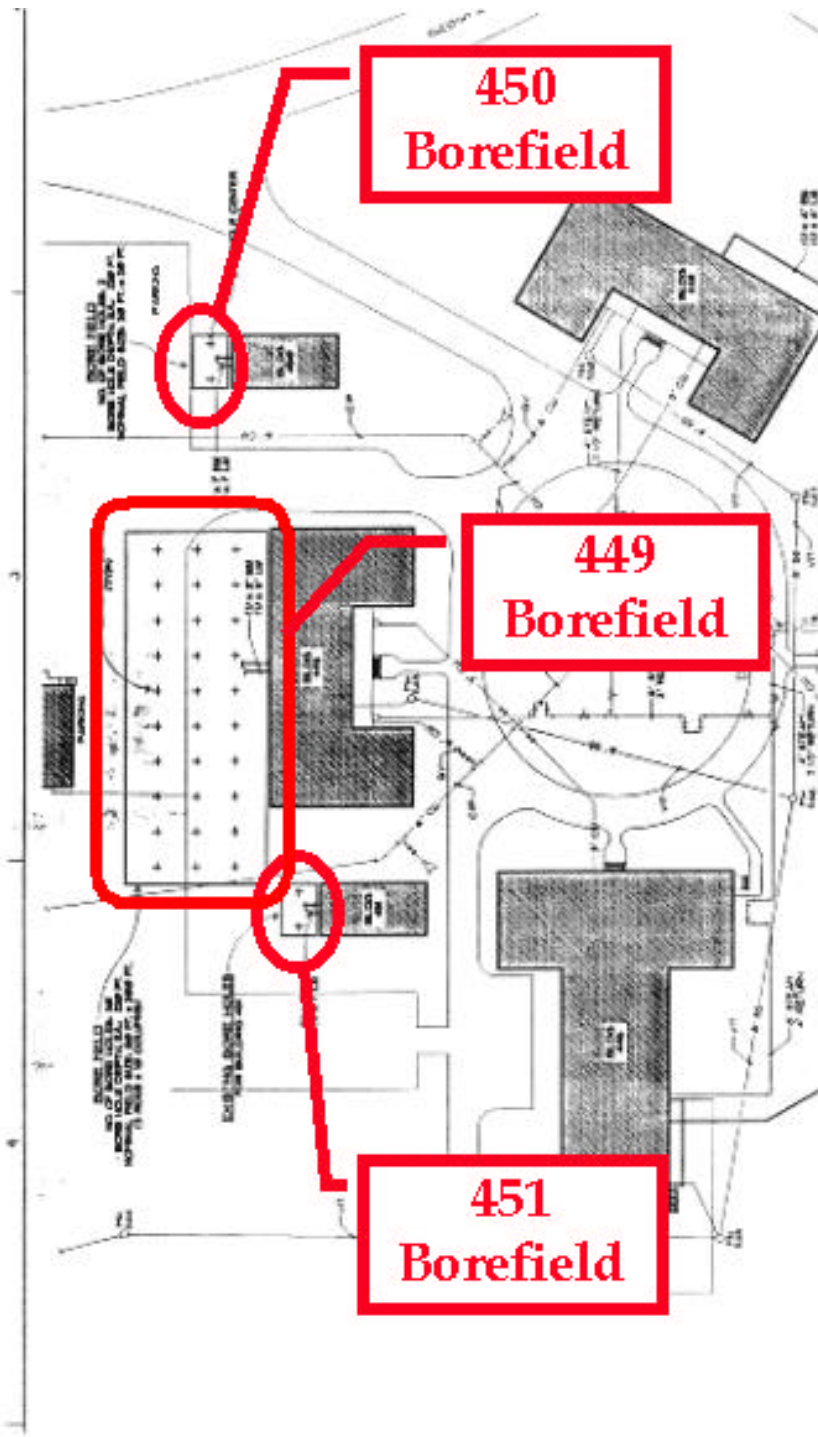
**Bo**

**440, 447, 448  
Borefield**

**451  
Borefield**









## Question

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“This is great stuff-will it work for my facilities?”



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## *Qualitative Qualifiers*

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- Are stakeholders sold on the technology?
- Are you virtuous?
- Can agency accept a long-term deal?
- Do you have sufficient real estate?





## *Quantitative Qualifiers*

### HVAC Repl't always long-payback

- Is your HVAC infrastructure in need of replacement?
  - Logical time: agency funds budgeted
- Are there maintenance savings to be realized?
  - Gov't chooses to lay off personnel (ESCO)
  - A-76 Contractor price reduction (Gov't)



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## *Quantitative Qualifiers*

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- Are your buildings running “wild”?
  - Systems on 24/7/365 & don't need to be
  - Existing control system not functioning
    - Not maintained
    - Too complicated for operators
- Can we do something with the rejected heat?



## *Quantitative Qualifiers*

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- Can we combine ECMs?
  - Combine w/shorter payback ECMs to reduce term
  - Typical combo:
    - Lighting
    - Geoexchange
    - Controls (KISS)





## *Quantitative Qualifiers*

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- Are you paying reasonable utility rates?
- Does your rate structure consider Load Factor?
  - 10% LF improvement could yield 1¢/kWh savings

$$LF = \frac{\text{Average Demand (kW)}}{\text{Maximum Demand (kW)}}$$



## *A few words on M&V*

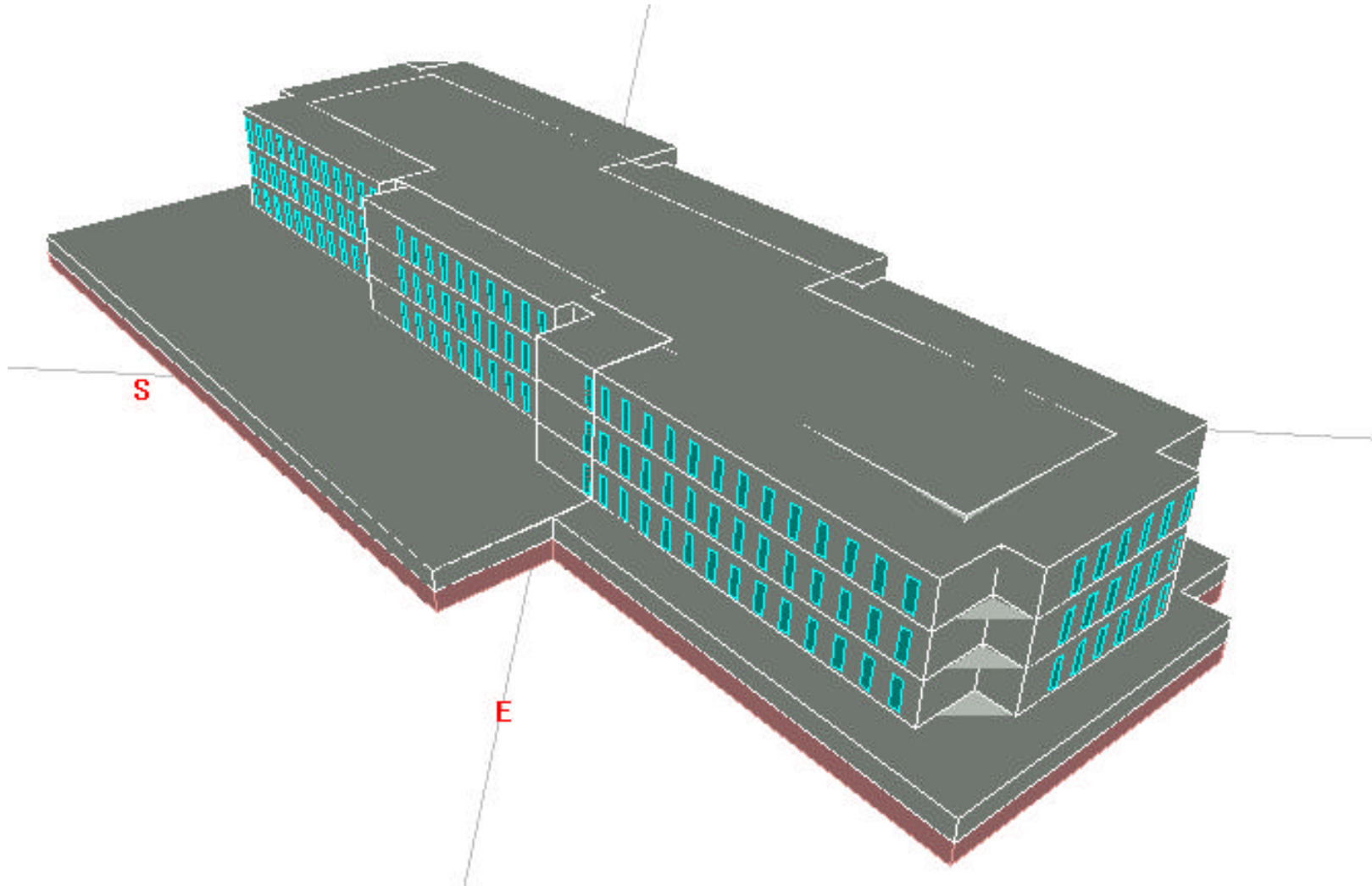
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- Challenge: Balance Cost & Precision
- Solution: FEMP Option D
  - Calibrated computer simulation of buildings
  - Permits modeling of complex interactions (ex.: solar loads, occupancy, bldg op. schedules)
  - Bonus: easily identify impact of operating parameters outside of ESCOs control



# ***Building Simulation***

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## *Option D*

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- Calibrated Model – existing bldg model
  - tweaked so predicted energy consumption = actual
- Baseline Model – often differs from Calibrated Model
  - Ex: Ventilation air req'ts
- Post Retrofit – new systems modeled
  - Predicted energy consumption used to determine savings from baseline



## *Parting Thoughts*

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- Get the right people involved!
  - Community of Geoexchange professionals remains relatively small
  - ORNL is excellent resource for technical assistance and project reviews



# An Energy Efficiency Workshop & Exposition

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